REMARKS/ARGUMENTS

Claims 1-87 are now pending in the Application. Claims 1, 28, 50 and 67 have been amended to more clearly define the invention. Claims 16-23 have been amended to update antecedent basis. The amendment of claims 16-23 is purely formal and no narrowing of the scope of the claims 16-23 is believed to result therefrom.

Claims 1-3, 11, 13 and 15 stand rejected under 35 U.S.C. §102(e) over United States Patent No. 6,140,670 to Chang (Chang). Applicant reserves the right to swear behind the Chang reference at a future date. The present invention relates to an improved diode for semiconductor devices. Claim 1 recites:

> A diode, said diode comprising: an isolation region formed in a substrate; a first doped active layer of a first conductivity type formed in said substrate, wherein said doped layer is spaced apart from said isolation region; a second doped active layer of a second conductivity type in contact with said first doped active layer, the contact of said first and second active layers forming a p-n junction; <u>and a third doped region formed in said second doped active layer beneath said isolation region</u>. (Emphasis added).

The Chang reference relates to "a photodiode structure having a first conductive type substrate and at least an isolation region, the photodiode structure comprising a doped second conductive type region, wherein the doped second conductive type region is formed in the substrate at a distance from the neighboring isolation region, and a mask layer covering at least a peripheral strip near the edge of the isolation region so that the doped second conductive type region is exposed." Column 2, lines 33-41. There is nothing in Chang, however, to teach or suggest, "a second doped active layer of a second conductivity type in contact with said first doped active layer, the contact of said first and second active layers forming a p-n junction; and <u>a third doped region formed in said second doped active layer beneath said isolation region,</u>" (emphasis added). Accordingly, Chang does not anticipate the present invention, or render it obvious. Therefore, the rejection of claim 1

under 35 U.S.C. §102(e) over Chang is overcome.

Claims 2, 3, 11, 13 and 15 each depend, directly or indirectly, from claim 1 and incorporate every limitation thereof. Accordingly, the rejections of claims 2,3, 11, 13 and 15 under 35 U.S.C. §102(e) over Chang is overcome for at least the same reasons given above in relation to claim 1.

Claims 5-7, 12 and 24-27 stand rejected under 35 U.S.C. §103(a) over Chang. Claims 5-7, 12 and 24-27 each depend, directly or indirectly, from claim 1 and incorporate every limitation thereof. In relation to claims 5-7, 12 and 24-27 respectively, the features of using a particular range for the space between the first doped region and the isolation region, using phosphorus for the dopant for the first doped active layer, and including a CCD imager array, a CMOS imager array, a memory array, and/or a logic array, are acknowledged by the Office Action to be absent from Chang. These features are asserted to be obvious.

However, as discussed above in relation to the rejection of claim 1 under 35 U.S.C. §102(e), there is nothing in Chang to teach or suggest the additional limitation of, "a third doped region formed in said second doped active layer beneath said isolation region." Accordingly, Chang does not anticipate the claimed invention or render it obvious, and the rejection of claims 5-7, 12 and 24-27 rejected under 35 U.S.C. §103(a) over Chang is overcome.

Claims 8-10 and 14 stand rejected under 35 U.S.C. § 103 (a) over Chang in view of United States Patent No. 5,942,775 to Yiannoulos (Yiannoulos). Claims 8-10 and 14 each depend, directly or indirectly, from claim 1 and incorporate every limitation thereof. The Office Action acknowledges that Chang does not teach or suggest "a first doped region of [the] second conductivity type... under the isolation region," and proposes to combine Yiannoulos with Chang in an effort to remedy this deficiency. Yiannoulos indicates that "the p-tub substrate region 133 adjoins other n-tub or p-tub regions 106 of the substrate 102." Column 41, lines 37-39. The Yiannoulos reference does not, however, teach or suggest, "a third doped region formed in said second doped active layer

beneath said isolation region." Therefore, Yiannoulos and Chang, taken alone or in combination, do not teach or suggest the claimed invention including "a third doped region formed in said second doped active layer beneath said isolation region." Accordingly, the rejection of claims 8-10 and 14 under 35 U.S.C. § 103 (a) over Chang in view of Yiannoulos is overcome.

Claims 4, 16-19, 28-34, 38-43, 45-57, 59, 61-63, 65-74, 78-83 and 85-87 stand rejected under 35 U.S.C. § 103 (a) over Chang in view of United States Patent No. 6,150,676 to Sasaki (Sasaki). Regarding claim 4, the Office Action acknowledges that Chang does not teach or suggest "a field oxide region formed by the Shallow Trench Isolation process." The Office Action emphasizes that Sasaki is <u>cited only</u> to show that it would have been an obvious matter of design choice for one of ordinary skill in the art to modify Chang by using STI regions. However, Claim 4 depends directly from claim 1 and incorporates all limitations thereof including "a third doped region formed in said second doped active layer beneath said isolation region." As discussed above, Chang does not teach or suggest these limitations, and the proposed combination of Chang with Sasaki does nothing to relieve this deficiency. Accordingly, the rejection of claim 4 under 35 U.S.C. § 103 (a) over Chang in view Sasaki is overcome.

With regard to claims 16-19, the Office Action notes that Sasaki discusses a third doped active layer that is spaced away from the edge of the first active layer. Chang and Sasaki, taken alone or in combination, do not, however, teach or suggest "a third doped region formed in said second doped active layer beneath said isolation region" along with "a fourth doped active layer at least partially within said first doped active layer." Accordingly, the rejection of claims 16-19 under 35 U.S.C. § 103 (a) over Chang in view of Sasaki is overcome.

Claim 28 recites:

> A diode for use in an imaging device, said diode comprising: an isolation region formed in a substrate; a first doped active layer of a first conductivity type

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formed in said substrate, said substrate being of a second conductivity type, wherein said first doped active layer is spaced apart from said isolation region; a second doped active layer of said first conductivity type formed within said first doped active layer, wherein said second doped active layer is doped to a higher dopant dose than said first doped active layer, wherein said first active layer and said substrate form a p-n junction; <u>and a third doped region proximate to a lower boundary of said isolation region</u>. (Emphasis added).

Sasaki relates to "a scaled pixel applicable to a MOS type image sensor that consists of an image area and a peripheral circuitry area having a peripheral circuit disposed in a first well region of a first conductivity type for driving the image area." Column 2, lines 38-42. However, Chang and Sasaki taken alone or in combination do not teach or suggest a, "first doped active layer...spaced apart from said isolation region...and a third doped region proximate to a lower boundary of said isolation region." Accordingly, the rejection of claim 28 under 35 U.S.C. § 103 (a) over Chang in view of Sasaki is overcome.

Claims 39-34, 38-43 and 45-49 each depend, directly or indirectly, from claim 28 and incorporate every limitation thereof. Accordingly, for at least the reasons given above in relation to claim 28 the rejections of claims 39-34, 38-43 and 45-49 under 35 U.S.C. § 103 (a) over Chang in view of Sasaki are overcome.

Claim 50 recites:

An imager device comprising: (i) a processor; and (ii) an imaging device coupled to said processor, said imaging device comprising: a photodiode for use in said imaging device, said photodiode comprising: an isolation region formed in a substrate; a first doped photoactive layer of a first conductivity type formed in said substrate, wherein said first doped layer is spaced apart from said isolation region; a second doped photoactive layer of a second conductivity type disposed in contact with said first doped photoactive layer, the contact of said first and second photoactive layers forming a p-n junction; and a third doped region

formed in said second doped photoactive layer beneath said isolation region. (Emphasis added).

Chang and Sasaki, taken alone or in combination, do not teach or suggest the unique combination of "a first doped photoactive layer of a first conductivity type formed in said substrate, wherein said first doped layer is spaced apart from said isolation region... and a third doped region formed in said second doped photoactive layer beneath said isolation region." Accordingly, the rejection of claim 50 under 35 U.S.C. § 103 (a) over Chang in view of Sasaki is overcome.

Claims 51-57, 59, 61-63, 65 and 66 each depend directly or indirectly from claim 50 and incorporate every limitation thereof. Accordingly, the rejections claims 51-57, 59 and 61-63, 65 and 66 under 35 U.S.C. § 103 (a) over Chang in view of Sasaki are overcome for at least the reasons given above in relation to claim 50.

Claim 67 recites:

> An imager device comprising: (i) a processor; and (ii) an imaging device coupled to said processor, said imaging device comprising: a photodiode for use in an imaging device, said photodiode comprising: an isolation region formed in a substrate; a first doped photoactive layer of a first conductivity type formed in said substrate, said substrate being doped to a second conductivity type, wherein said first doped photoactive layer is spaced apart from said isolation region; a second doped photoactive layer of said first conductivity type formed within said first doped photoactive layer, wherein said second doped photoactive layer is doped to a higher dopant dose than said first doped photoactive layer, wherein said first photoactive layer and said substrate form a p-n junction; and a third doped region formed in said substrate beneath said isolation region and spaced apart from said first photoactive layer. (Emphasis added).

Chang and Sasaki taken alone or in combination, do not teach or suggest the unique combination of "a first doped photoactive ... wherein said first doped photoactive

layer is spaced apart from said isolation region; ... and a third doped region formed in said substrate beneath said isolation region and spaced apart from said first photoactive layer." Therefore the proposed combination of Chang and Sasaki does not anticipate claim 67 or render it obvious. Accordingly, the rejection of claim 67 under 35 U.S.C. § 103 (a) over Chang in view of Sasaki is overcome.

Claims 68-74, 78-83 and 85-87 each depend directly or indirectly from claim 67 and incorporate every limitation thereof. Accordingly, the rejections of claims 68-74, 78-83 and 85-87 under 35 U.S.C. § 103 (a) over Chang in view of Sasaki are overcome for at least the reasons given above in relation to claim 67.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "Version with markings to show changes made."

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

Dated: 0 5 MAY 2003

Respectfully submitted,

By [signature]

Thomas J. D'Amico
Registration No.: 28,371
Michael Bergman
Registration No.: 42,318
DICKSTEIN SHAPIRO MORIN & OSHINSKY LLP
2101 L Street NW
Washington, DC 20037-1526
(202) 785-9700
Attorneys for Applicant

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Version with Markings to Show Changes Made

Please rewrite claims 1, 16-23, 28, 50 and 67 as follows:

1. (Amended) A diode, said diode comprising:

an isolation region formed in a substrate;

a first doped active layer of a first conductivity type formed in said substrate, wherein said doped active layer is spaced apart from said isolation region; [and]

a second doped active layer of a second conductivity type in contact with said first doped active layer, the contact of said first and second active layers forming a p-n junction; and

a third doped region formed in said second doped active layer beneath said isolation region.

16. (Amended) The diode according to claim 1, further comprising a [third] fourth doped active layer at least partially within said first doped active layer.

17. (Amended) The diode according to claim 16, wherein said [third] fourth doped active layer is spaced away from the edge of said first doped active layer.

18. (Amended) The diode according to claim 16, wherein said [third] fourth doped active layer is an n-type region.

19. (Amended) The diode according to claim 16, wherein said [third] fourth doped active layer is doped at a dopant dose of from about $1x10^{12}$ ions/cm^2 to about $1x10^{16}$ ions/cm^2.

20. (Amended) The diode according to claim 9, further comprising a [third] fourth doped active layer at least partially within said first doped active layer.

21. (Amended) The diode according to claim 20, wherein said [third] <u>fourth</u> doped active layer is spaced away from the edge of said first doped active layer.

22. (Amended) The diode according to claim 20, wherein said [third] <u>fourth</u> doped active layer is an n-type region.

23. (Amended) The diode according to claim 20, wherein said [third] <u>fourth</u> doped active layer is doped at a dopant dose of from about $1x10^{12}$ ions/cm^2 to about $1x10^{16}$ ions/cm^2.

28. (Amended) A diode for use in an imaging device, said diode comprising:

an isolation region formed in a substrate;

a first doped active layer of a first conductivity type formed in said substrate<u>, said substrate being</u> of a second conductivity type, wherein said first doped active layer is spaced apart from said isolation region; [and]

a second doped active layer of [a] <u>said</u> first conductivity type formed within said first doped active layer, wherein said second doped active layer is doped to a higher dopant dose [that] <u>than</u> said first doped active layer, wherein said first [and second] active [layers] <u>layer</u> and said substrate form a p-n junction<u>; and</u>

<u>a third doped region proximate to a lower boundary of said isolation region</u>.

50. (Amended) An imager device comprising:

(i) a processor; and

(ii) an imaging device coupled to said processor, said imaging device comprising:

a photodiode for use in [an] <u>said</u> imaging device, said photodiode comprising:

an isolation region formed in a substrate;

a first doped photoactive layer of a first conductivity type formed in said substrate, wherein said first doped layer is spaced apart from said isolation region; [and]

a second doped photoactive layer of a second conductivity type disposed in contact with said first doped photoactive layer, the contact of said first and second photoactive layers forming a p-n junction; and

a third doped region formed in said second doped photoactive layer beneath said isolation region.

67. (Amended) An imager device comprising:

(i) a processor; and

(ii) an imaging device coupled to said processor, said imaging device comprising:

a photodiode for use in an imaging device, said photodiode comprising:

an isolation region formed in a substrate;

a first doped photoactive layer of a first conductivity type formed in said substrate, said substrate being doped to a second conductivity type, wherein said first doped photoactive layer is spaced apart from said isolation region; [and]

a second doped photoactive layer of [a] said first conductivity type formed within said first doped photoactive layer, wherein said second doped photoactive layer is doped to a higher dopant dose [that] than said first doped photoactive layer, wherein said first [and second] photoactive [layers] layer and said substrate form a p-n junction; and

a third doped region formed in said substrate beneath said isolation region and spaced apart from said first photoactive layer.